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(54) Thermal linear actuator

(57) A linear actuator includes a wax filled piston and cylinder device (16), (10) having means (38) for heating the wax. As shown the heater is electrical and is supplied with pulsed current. The pulse length is controlled to give the desired temperature change in the wax. Internal and external fins (14), (12) increase heat transfer rates. Heating may be provided by a gas burner or via a heat exchanger. The heating means (38) may be controlled by temperature, humidity, light or sound sensors. The actuator may control a ventilation flap in a piggery.

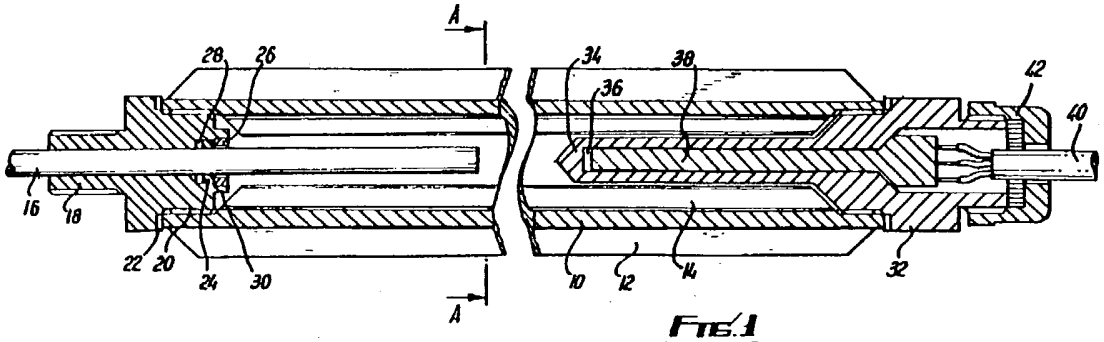

FIG.1

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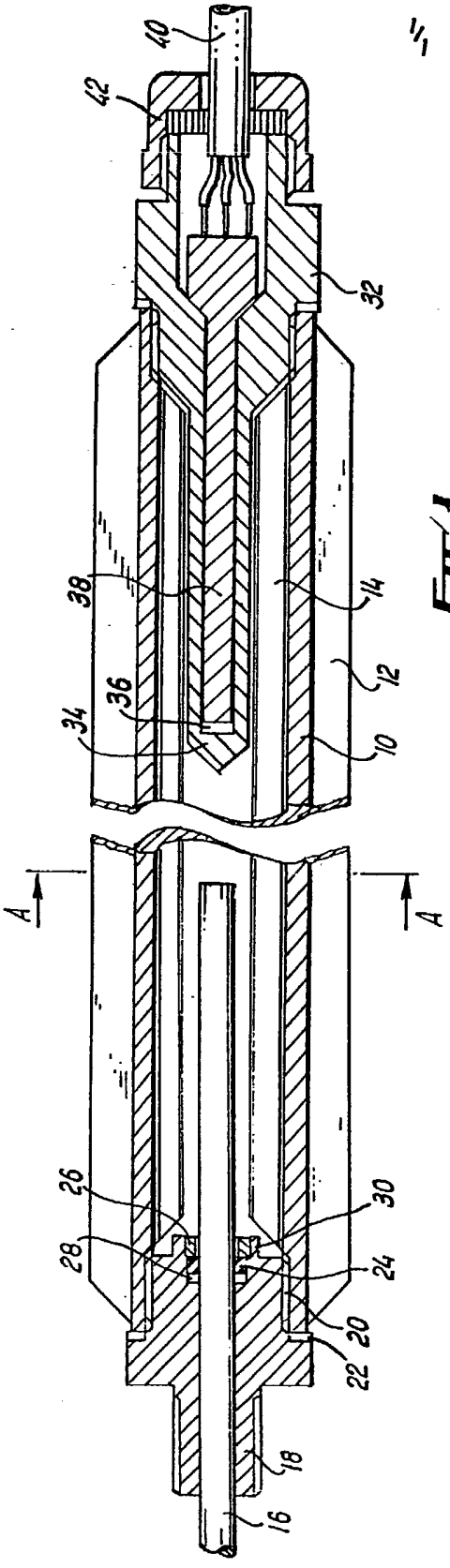

FIG.1

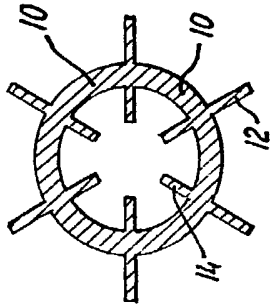

FIG.2

SPECIFICATION

Improvements in or relating to linear actuators

The present invention concerns improvements in or relating to linear actuators, especially but not exclusively wax filled linear actuators intended to operats as a result of change in, for example, temperature.

There are presently known wax filled linear actuators which comprise essentially a piston and cylinder assembly, the cylinder being filled with a wax which expands on being heated or contracts on being cooled to move the piston thereby causing relative movement between the piston rod and the component to which it is attached and the cylinder and another component to which it is attached.

In certain inatances actuators of this type are sufficiently sensitive but in other inatances especially where a relatively rapid response as a result of even a minor temperature fluctation is required existing actuators are not adequate.

It is an object of the present invention to obviate or mitigate this disadvsntage.

According to the present invention there is provided a linear actuator comprising a piston and cylinder assembly, the cylinder of which is filled with a wax of a type which expands on absorbing heat, and heat supply in response to a change in certain conditions.

Preferably the heating means is located within the cylinder. The heating means may be an electrical element. Preferably the means provided for supplying current to the heating element is such that the current is supplied in pulses, the amount of heat being determined by the length of each pulse. Preferably control means for the heating means are sensitive to temperature change whereby on detecting a rise in temperature a greater quantity of heat is supplied to the wax by the heating means.

In modifications the heating means may include a gas flame or a heat exchanger supplied by a hot liquid or gas, a control valve being provided in a supply to said flame or exchanger to control heat emitted therefrom.

Preferably the heating means is so regulated that in operation of the actuator the wax temperature is maintained within the range 50—60°C.

Preferably the cylinder is provided with external and internal heat exchange fins.

An embodiment of the present invention will now be described by way of example only with reference to the accompanying drawings, in which:

Fig. 1 shows a longitudinal cross-section through a linear actuator with a central part thereof omitted; and

Fig. 2 shows a cross-section of a cylinder of the actuator through the line A-A of Fig. 1.

Linear actuators incorporating wax filled piston and cylinder assemblies are known. These actuators operate with the wax at ambient temperature so that as the temperature of the wax is increased as a result of a rise in the ambient temperature it expands and causes the piston to move out of the cylinder so that linear actuation in response to a temperature rise can be obtained. By the same token linear actuation in the opposite direction can be obtained on retraction of the piston into the cylinder as a result of a contraction of the wax when the ambient temperature drops.

The efficiency of certain waxes in such operating conditions is much enhanced if the wax operates at a higher temperature, for example in the range 50—60°C. In the present invention an electrical heating element for raising the normal operating temperature of the wax to the range 50—60°C is provided within the cylinder.

In Fig. 1 there is shown a linear actuator having a tubular cylinder 10 provided with external heat transfer fins 12 and internal heat transfer fins 14. A piston rod 16 is slidably mounted in a gland 18 which is mounted by threads 20 in the end of the cylinder 10 and sealed thereagainst with the aid of a resilient seal 22. A further seal 24 is provided in the gland around the piston rod 16, this further seal 24 being held in place by a plastics material outer ring 26 and a pressure ring 28, the assembly of seal and rings being held in the gland by swaging over an integral annular extension 30 of the gland (Fig. 1 showing the extension before swaging). A similar gland-like arrangement 32, which will not be described in detail, is provided at the other end of the cylinder 10, the arrangement 32 having a portion 34 projecting into the cylinder and having formed therein a pocket 36 for an electrical heating element 38. A power supply 40 for the heating element extends through a cable mounting means and lock nut assembly 42 on the arrangement 32.

The supply 40 extends to an electronic control assembly incorporating or connected to a thermistor. The control assembly takes an electrical supply from the mains and converts it to pulses which are fed by way of the supply cable 40 to the heating element 38. The thermistor senses temperature changes and on encountering a temperature rise causes the control means to increase the duration of the energy pulses to the heating element such that the element inputs more heat to a high temperature wax filling the cylinder 10. In normal operating circumstances, that is where the thermistor does not detect any temperature rise or fall, the pulses are of such duration that the heat supplied to the wax maintains it at a constant predetermined temperature lying within the range 50 -60°C. An increase in temperature sensed by the thermistor causes the duration of the pulses to increase by an amount proportional to the temperature rise

so that on passing the increased heat to the wax it expands by a predetermined amount to eject the piston rod 16 from the piston to cause movement of the rod which is proportional to the temperature rise.

It will be appreciated therefore that by connecting the linear actuator between, for example, a ventilation flap in a building and a frame for the flap, ventilation can be increased on an increase in temperature as a result of movement of the piston rod 16 out of the cylinder 10.

The operating temperature of the wax is chosen such that it lies in a range where the graph of expansion against temperature change is steepest, in other words the actuator operates with the wax in its most efficient temperature range so that it is most sensitive to temperature variation.

To increase the actuator's sensitivity the cylinder is provided with external and internal heat transfer fins 12, 14. These serve two main functions, that is they assist in the dissipation of heat from the cylinder when it is desired to cause the piston rod to retract as a result of a temperature drop due to the increased heat transfer area presented by the fins and also to ensure that heat is lost from the body of wax within the cylinder in the most efficient manner, bearing in mind that wax is a poor conductor of heat and without the internal heat transfer fins the heat path for loss of heat from the wax would be considerably increased.

With the arrangement described above sensitivity as low as 0.2°C can readily be obtained.

Various modifications can be made without departing from the scope of the present invention. For example, the thermistor could be replaced by a sensor sensing different conditions, for example humidity, light or sound, or by an arrangement giving a command in response to any chosen change in conditions, for example a microprocessor analysing several conditions around a building. Furthermore, heat could be supplied to the wax not by an electrical heating element but by a gas flame or a heated liquid or gas heat exchanger. In these latter modifications the electronic control means connected to the sensor would be called upon to actuate a valve controlling the gas for combustion or liquid or gas to and from the heat exchanger.

Various modified heat transfer fins could be provided for the cylinder and the means for mounting the piston rod and heating element could be modified in any desired way.

The present invention is particularly applicable to controlling the temperature of buildings in which livestock is being kept. It has been found during the rearing of pigs, for example, that the quality and yield of the pig can be considerably increased if the temperature of the building in which it is being raised is carefully controlled in accordance with certain factors, for example the age and weight of the pig.

CLAIMS

1. A linear actuator comprising a piston and cylinder assembly, the cylinder of which is filled with a wax of a type which expands on absorbing heat, and means for supplying heat to the wax and varying the heat supply in response to a change in certain conditions.

2. An actuator as claimed in claim 1, in which the heating means is located within the cylinder.

3. An actuator as claimed in claim 1 or claim 2, in which the heating means is an electrical element.

4. An actuator as claimed in claim 3, in which the means provided for supplying current to the heating element is such that the current is supplied in pulses, the amount of heat being determined by the length of each pulse.

5. An actuator as claimed in claim 1, in which the heating means includes a gas flame.

6. An actuator as claimed in claim 1, in which the heating means includes a heat exchanger supplied by a hot liquid or gas.

7. An actuator as claimed in claim 5 or claim 6, in which a control valve is provided in a supply to said flame or exchanger to control heat emitted therefrom.

8. An actuator as claimed in any one of the preceding claims, in which control means for the heating means are sensitive to temperature change whereby on detecting a rise in temperature a greater quantity of heat is supplied to the wax by the heating means.

9. An actuator as claimed in any one of the preceding claims, in which the heating means is so regulated that in operation of the actuator the wax temperature is maintained within the range 50—60°C.

10. An actuator as claimed in any one of the preceding claims, in which the cylinder is provided with external and internal heat exchange fins.

11. A linear actuator substantially as hereinbefore described with reference to the accompanying drawings.

12. Any novel subject matter or combination including novel subject matter herein disclosed, whether or not within the scope of or relating to the same invention as any of the preceding claims.

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